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FRUIT QUALITY IN RELATION TO CROP LOAD OF DEGLET NOOR DATES

By J. R. Furr, W. W. Armstrong, Jr., and P. S. Lieu

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In recent years the proportion of high-quality fruit in the Deglet Noor date crop has declined. The decrease has been attributed largely to such changes in practice as less severe thinning and less frequent picking of fruit. Because of increasing labor costs, growers are unlikely to return to more frequent picking in their effort to improve fruit quality. Modification of current thinning practices is possible, however, at little or no additional cost.

Extreme overloading, such as is caused by retaining all bunches with no thinning, results in small, poorly fleshed fruit, much shrivel, delayed ripening, and serious alternate bearing; extremely heavy thinning results in over-sized fruit, severe checking and blacknose, and low yields (1, 2).

The object of the work reported in this paper was to study the influence of a wide range of crop load on fruit size and quality.

MATERIALS AND METHODS

The trees used in the crop-load experiment were grown at the U. S. Date Field Station, Indio, California, on Indio very fine sandy loam. They were 11 years old at the start of the test in 1958 and had possibly attained full bearing in 1960. They received 6 pounds of nitrogen per tree per year from ammonium nitrate in winter or early spring. About one year's growth of leaves was pruned off each year in June or July.

Irrigation water from the Coachella Valley branch of the All American Canal was applied at intervals of about 4 weeks in winter and 2 weeks to 10 days in summer. The total amount applied per year was 10 to 12 feet. The supply of nitrogen fertilizer and water was probably adequate for nearly maximum growth and fruit production.

The fruit-thinning treatments consisted of variations in percentage of inflorescences retained each year and allowed to mature fruit. There were 10 single-tree replications of the following percentages: 100%, 80% 60%, 40%. After all the inflorescences had emerged, those produced by each tree were counted, and at thinning-and-tying-down-time unwanted bunches on each tree were removed. All bunches retained were thinned uniformly. When inflorescences were pollinated, tips of the strands were cut back uniformly; and when bunches were tied down, they were thinned by removal of strands from the centers of the bunches. The same number of strands was retained on all bunches. In 1958 and 1959, 35 strands with 35 to 40 fruits each were retained on each bunch; in 1960, the bunch size was 40 strands of approximately 40 fruits per strand.

Each year two main pickings and a small clean-up picking of fruit were made. Samples of 200 fruits per tree from each of the first 2 pickings were weighed to determine fruit size. Upon delivery of the fruit to the packing house, door-samples were taken and graded in the usual manner by the California Date Growers' Association.

At pruning on July 18, 1960, the leaves on each tree were counted, and in August counts were made to determine the average number of fruits per strand.

RESULTS AND DISCUSSION

A comparison of data obtained in August 1960 concerning bunch size and number of bunches on trees under different thinning treatments with similar data obtained by Parr in August 1959 in a survey of 10 Deglet Noor date gardens (3) indicates that the average crop load of trees in the commercial gardens was slightly less than that of trees in the crop-load experiment in which 80% of the bunches were retained (Table 1). The average bunch in the crop-load experiment had 40 strands of 42.3 fruit per strand as compared with an average bunch of 38 strands of 36.6 fruit per strand recorded in the Parr survey. The difference in bunch size accounts for the fact that trees in the crop-load test on which 100% of the bunches were retained carried considerably larger crop loads than the average tree in the Parr survey even through the latter trees had nearly as many bunches per tree as the trees under the 100% treatment in the crop-load test.

Leaf pruning in 1960 was slightly heavier than normal, the number of fully expanded leaves being reduced from about 132 leaves per tree to about 100 leaves. Except for the trees on which 100% of the bunches were retained, the number of leaves per bunch was equal to or above the level recommended as essential to avoid serious alternate bearing (1), and even these trees for a short time before the leaves were pruned had a leaf-bunch ratio equal to the recommended level.

Perhaps the fact that the fruit bunches were smaller in 1958 and 1959 than in 1960 accounts in part for lack of pronounced alternate bearing of the trees on which 100% of the bunches were retained (Table 2). Except in 1959, when the trees under all treatments produced a somewhat larger number of inflorescences than usual, bearing was remarkably regular.

In view of the wide variation in crop load which might be expected to influence inflorescence production, the maximum deviation from the mean number of inflorescences produced by trees under each treatment from 1958 to 1961 was surprisingly small (Table 2). Severe reduction in number of bunches on trees under the 40% treatment apparently increased inflorescence production slightly, but neither heavy crop load nor severe bunch reduction induced alternate bearing.

Crop load measurably influenced fruit size, as indicated by weight of

Table 1. Comparison of bunch size and number of bunches per tree in the crop load experiment in 1960 with those in the Parr survey, and the relation of leaves per bunch to crop load.

Items compared	Treatment: bunches retained				Parr
	100%	80%	60%	40%	survey
Bunches per tree	14.5	11.8	9.8	7.2	14.3
Strands per bunch	40.0	40.0	40.0	40.0	38.0
Fruits per strand	43.0	42.2	42.3	41.9	36.6
Fruits per tree	24,940.0	19,918.0	17,526.0	12,067.0	19,888.0
Leaves per tree before pruning	131.3	132.7	129.3	135.3	
Leaves per tree after pruning	97.8	96.5	99.0	103.7	
Leaves per bunch before pruning	9.1	11.2	13.2	18.8	
Leaves per bunch after pruning	6.7	8.2	10.1	14.4	

mature fruits. In 1958 fruits from trees on which 40% of the bunches were retained were significantly larger than fruits from trees with heavier crop load (Table 3). The difference in average weight of individual fruits from trees under the 40% treatment and those under the 100% treatment was: in 1958 almost 2 grams, in 1959 one gram, and in 1960 only 0.65 gram. The difference in size of fruits from trees under the 60% and 80% treatments in 1958 was not significant, but fruits from trees under the 60% treatment were larger than those from trees under the 100% treatment. In 1959 and 1960 fruits from the various treatments were smaller than in 1958. This decrease probably resulted from the increase in crop load under all treatments in 1959 and 1960. In general, size of fruit in the 1958 and 1959 crops increased with decrease in crop load, but in 1960 differences in size of fruits from trees under different treatments were less than in the two preceding years.

The trees in this experiment, regardless of crop load, produced little A grade fruit (Table 4). The major part of the crop produced under each treatment was classed as B grade. Percentages of B grade fruit produced under the different treatments followed no consistent order. The high-1960 by trees under the 80% treatment.

Table 2. Inflorescence production and regularity of bearing in relation to crop load.

Items related and year	Treatment: bunches retained 100%	80%	60%	40%
Av. number of inflorescences produced per tree in:				
1958	15.3	14.5	14.6	14.7
1959	18.0	17.2	17.9	19.5
1960	14.5	15.0	16.3	18.1
1961	14.3	15.0	15.7	19.4
Av. 1958-1961	15.5	15.4	16.1	17.9
Maximum deviation from mean number of inflorescences per tree produced in:				
1958	1.7	3.5	2.6	2.7
1959	2.0	1.2	3.9	2.5
1960	1.5	3.0	1.7	2.9
1961	3.7	2.0	3.3	1.6
Av. number of bunches per tree retained in:				
1958	14.6	11.4	8.8	5.9
1959	18.0	13.8	10.6	7.8
1960	14.5	11.8	9.8	7.2
1961	14.3	12.0	9.3	7.8
Av. 1958-1961	15.4	12.3	9.6	7.2

Table 3. Fruit size, as indicated by average weight (grams) per fruit, in relation to crop load.

Treatment: bunches retained	1958[1]	1959[1]	1960[1]
100%	9.8 x	8.5 x	8.3 x
80%	10.3 xy	8.9 xy	8.4 xy
60%	10.4 y	9.1 yz	8.4 xy
40%	11.7 z	9.5 z	9.0 y
Significance	**[2]	**[2]	**[2]

[1]Values are significantly different if they do not have a common subscript letter.
[2]**Significant at 1 percent level.

With increasing crop load, however, there was a marked increase in est percentage of B grade fruit was produced in 1958 by trees under the 100% treatment, in 1959 by trees under the 40% treatment, and in the actual amount (pounds) of B grade fruit. This obviously resulted from the increase in total yield with increasing percentage of bunches retained. Total yields were greatest on trees on which 100% of the bunches were retained and, as would be expected, decreased with decreasing percentage of bunches retained. Under current market conditions the amount of B grade fruit produced is of prime importance because the grower receives about twice as much for B grade fruit as for C grade, and under present production practices there is little hope of appreciably increasing the production of A grade fruit.

Percentages of field culls were small, differences seemed unrelated to the thinning treatments, and records of field culls are consequently not reported.

CONCLUSIONS

From the results of this investigation of the influence of crop load on vigorous Deglet Noor palms bearing 100 to 135 leaves per tree and maturing bunches of 35 to 40 strands of fruit the following conclusions may be drawn:

1. Decreasing crop load progressively from 100% to 80%, 60%, or 40% of the bunches produced increased average fruit size, but the increase did not compensate for the resultant reduction in yield of marketable fruit.

2. Serious alternate bearing did not result from the heaviest crop loads borne by these trees, which in 1959 and 1960 amounted to yields of 14,000 to 16,000 pounds per acre.

3. Regardless of crop load, the trees in this experiment produced little A grade fruit and the percentage of B grade fruit produced was unrelated to crop load. The amount (pounds) of B grade fruit produced per tree, however, markedly increased with increasing crop load.

4. The marked increase in amount of B grade fruit with increasing crop load is important economically, because under current conditions of production and marketing the amount of B grade fruit produced largely determines monetary returns for the Deglet Noor crop.

5. The heaviest crop loads pro-

Table 4. Percentage and weight per tree of fruit in the different grades in relation to crop load.

Grade and year	Treatments: bunches retained 100% (%)	100% (lbs.)	80% (%)	80% (lbs.)	60% (%)	60% (lbs.)	40% (%)	40% (lbs.)
1958:								
A	4	7	8	12	5	6	5	4
B	78	136	75	117	68	79	72	59
C	9	16	12	19	23	26	20	16
D	9	16	5	8	4	5	3	2
Total		175		156		116		81
1959:								
A	1	3	1	3	0	0	0	0
B	78	262	76	222	81	202	83	167
C	17	57	19	56	14	35	13	26
D	4	13	4	12	5	12	4	8
Total		335		293		249		201
1960:								
A	1	3	1	3	0	0	0	0
B	76	225	80	222	77	195	79	163
C	19	56	16	44	18	46	17	35
D	4	12	3	8	5	13	4	8
Total		296		277		254		206

duced in this test were the most profitable.

SUMMARY

Crop load on Deglet Noor date palms was controlled by varying the percentages of bunches retained for fruiting in 4 replicated treatments as follows: 100%, 80%, 60%, 40%.

With bunches of uniform size, increasing the crop load over the range from 40% to 100% of bunches retained to maturity resulted in: a moderate decrease in fruit size; little influence on percentages of various grades of fruit; a large increase in total yield; a large increase in the actual amount (pounds) of B grade fruit, which comprised the major part of the crop; no influence on regularity of bearing; and a large increase in monetary return because of the dominant effect of B grade fruit on value of the crop.

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SUCROSE INVERSION IN DEGLET NOOR DATES AND ITS PROCESSING APPLICATIONS[1]

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Inversion of sucrose in domestic Deglet Noor dates has been observed for many years and has been considered to be a detrimental side effect in date processing and storage. As early as 1911, Vinson reported the role of the enzyme invertase in causing sucrose inversion in dates (7). Other workers also recognized the general effects of temperature and moisture on inversion through their work on artificial ripening, storage, and steam hydration of dates (1, 2, 6).

In the course of previous studies at this laboratory on chemical changes in Deglet Noor dates during storage it appeared that the dates became softer as inversion progressed. Exploratory studies conducted under more favorable conditions confirmed the softer texture, and also indicated that invert sugar Deglets had a lower equilibrium relative humidity, a good invert date flavor, and a pleasing medium brown color. Because of these desirable qualities, it was of interest to study more fully the factors affecting inversion in dates so that a practical process could be developed.

This paper reports the effect of temperature, moisture content, and added invertase upon the rate of the inversion process, and discusses the practical application of the process and the qualities of the dates produced.

EXPERIMENTAL

Analytical methods: The relative humidity of date pieces (roughly ¼ x ½" in size) was measured with an electric hygrometer (5). Their texture was estimated by measuring the pressure in pounds required to flatten them with a blunt probe attached to a spring-loaded pressure gauge. The moisture content of the dates was determined by drying 2.5 grams of ground tissue under vacuum (20 mm) at 140° F. for 20 hours. Sugars were removed from the date tissue by extraction with 80% ethanol. Reducing sugars were determined titrametrically by a ferricyanide method (3)

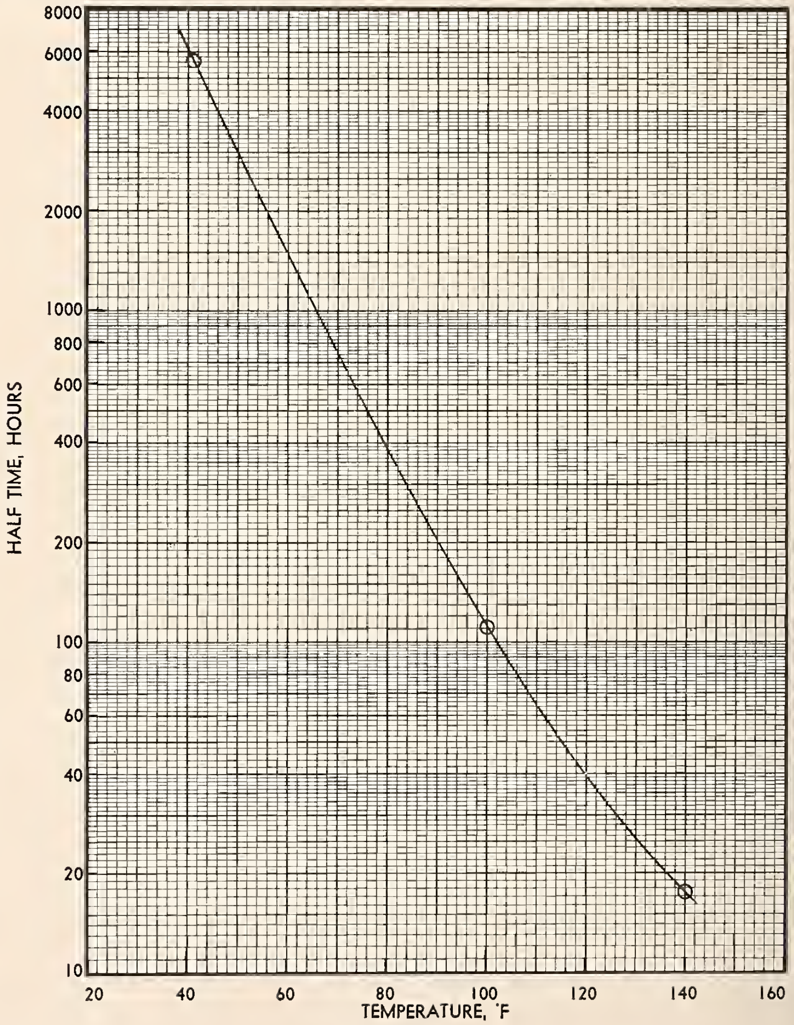

Figure 1.

[1] *Work supported in part by Date Administrative Committee, Indio, California.*

[2] *A laboratory of the Western Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture.*

and reported in terms of percent total sugar as glucose. Total sugars were also determined by this method after hydrolysis with invertase. Sucrose was determined, using the appropriate calculation, as the difference between total sugars and reducing sugars. The two grades of invertase used were melibiose free invertase (K value = about 15), hereafter called pure invertase, and powdered crude invertase. A syringe was used to inject either a 0.1 ml. solution containing 2 mg. of pure invertase or a 0.1 ml. suspension containing 5 mg. of crude invertase into each date. Controls were injected with 0.1 ml. of water.

Experimental procedure: The fruit used in these experiments was selected from a 45 pound lot of commercially pitted Deglet Noor dates which were graded to insure uniformity of moisture content, size, and color. They were hydrated or dehydrated at 100° F. to provide a range of moisture contents, 14.6 to 31.6%.

To determine rates of inversion randomly selected samples consisting of 10 dates of the required moisture content were placed in air-tight jars which were then held at constant temperature. Samples were removed at various times and sugar analyses performed. Rates were determined by plotting logarithm % sucrose vs. time. In most cases 4 to 6 points were used. The rate constant is equal to 2.3 times the slope of the straight line obtained from this plot. The rate of inversion is reported as the half-time, which is the length of time required to invert one half the sucrose. The half-time, which is calculated by dividing the rate constant into 0.69, is a constant regardless of the initial sucrose concentration, provided enzyme concentration and environmental factors are constant. A short half-time indicates a rapid rate of inversion and a long half-time a slow rate.

RESULTS AND DISCUSSION

Temperature: Sucrose inversion becomes more rapid as the temperature increases (Fig. 1). For example, at 100° F. it takes 111 hours to invert 50% of the sucrose in 31% moisture dates whereas at 140° F. it takes only 17.5 hours. Thus a forty degree rise in temperature, (from 100° F. to 140° F.) causes the inversion reaction to proceed 6.3 times faster. When the data are plotted in accordance with the Arrhenius equation a straight line is obtained. This shows that the effect of temperature on sucrose inversion in dates follows the same law as chemical reactions in general. However, for practical purposes a plot of logarithm half-time versus temperature in degrees Fahrenheit, Fig. 1, is more useful

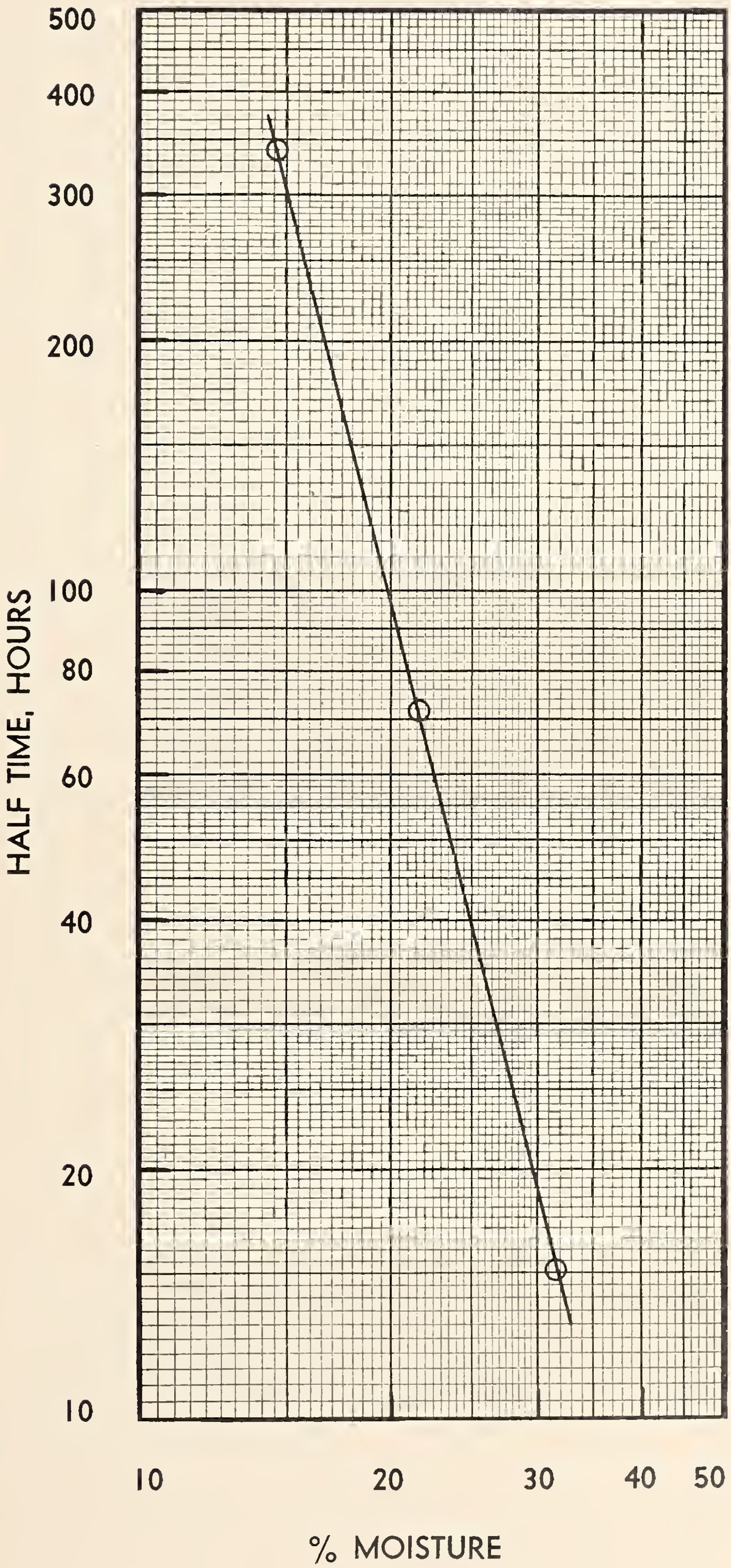

Figure 2. *Effect of moisture content on rate of sucrose inversion in ground tissue at 140° F.*

since the half-time for any temperature between 41° and 140° F. (for dates of 31% moisture content) can be read directly from the graph.

It is apparent that temperatures in the vicinity of 140° F. are required to invert sucrose in dates rapidly enough to be considered industrially practical. The use of higher temperatures is probably possible, but undesirable changes may be more pronounced.

Moisture: Data given in Fig. 2 and Table 1 show the effect of moisture content on the rate of inversion in ground tissue and whole, pitted dates respectively at 140° F. An increase in moisture content accelerates the inversion process.

When a plot of logarithm% moisture content vs. logarithm half-time is made using the data on ground tissue, a straight line is obtained (Fig. 2). Predictions of half-times for whole, pitted dates based on the linear relationship established with data on ground tissue agree with observed values for whole dates (Table 1). This indicates that the rate of sucrose inversion under these conditions is not affected to a significant extent by the physical state of the tissue. The rate of inversion at 140° F. for dates of any moisture content within the experimental range 14.6 to 31.6% can be estimated from the graph. Further work is necessary to determine if a similar linear relationship holds for temperatures other than 140° F. and for moisture contents outside the experimental range.

Invertase is present naturally in Deglet Noor dates, but it is relatively inactive at low moistures. If sucrose is to be converted into invert sugar in a reasonable length of time the fruit should be brought to a high moisture content in order to reactivate the invertase sufficiently. Conversely, if it is desired to slow inversion the dates should be adjusted to a low moisture content. Fastest rates will occur at high temperatures and high moistures and vice versa. In addition, previous work has shown that inversion can be prevented by a short high-temperature treatment, which permanently destroys the enzyme (4).

Added Invertase: Table 2 shows that addition of pure invertase to pitted dates increases the rate of inversion. For example, at 140° F. with dates of 22.1% moisture content the rate of inversion in the treated dates is 1.32 times faster than in the untreated control. With dates of 30.8% moisture content, inversion proceeds 1.95 times faster. These results also show that higher moisture contents increase the effectiveness of the enzyme treatment.

Since the results with pure invertase were encouraging it was of interest to determine whether the less expensive crude invertase would also be effective. Table 3 shows that at 140° F. with dates of 27.4% moisture content sucrose inversion is 1.4 times faster in the dates treated with crude invertase than in the untreated control. If the control dates contained 30% invert sugar they would require a 31.9 hour holding period to reach 65% invert sugar. The holding period is equal to the half-time since one half the initial sucrose has been inverted in this example. If these same dates were treated with crude invertase the holding period would be reduced to 23 hours. Judging from the results with pure invertase, the crude enzyme treatment would be more effective at higher moisture levels. Increasing the amount of enzyme used would probably also increase the rate of inversion. The cost of the 5 mg. of crude invertase per date used in the laboratory test amounts to 75 cents per 1000 pounds of dates (5 mg. of crude invertaste per date is equivalent to about one half pound of enzyme per 1000 pounds). Tests on a commercial scale would be required to determine the actual industrial cost of this process.

Properties: During sucrose inversion the following reaction takes place:

$$\underset{\text{1 Sucrose}}{C_{12}H_{22}O_{11}} \xrightarrow{+H_2O} \underbrace{\underset{\text{1 Glucose}}{C_6H_{12}O_6} + \underset{\text{1 Fructose}}{C_6H_{12}O_6}}_{\text{Invert Sugar}}$$

This means that for each mole of sucrose hydrolyzed one mole each of glucose and fructose are formed. Since the relative humidity in equilibrium with a solution is an inverse function of the number of moles of solute dissolved, sucrose inversion in dates of a given moisture content should result in a decrease in their equilibrium relative humidity. When treated and untreated date pieces are adjusted to the same relative humidity the former have a higher moisture content as shown in Table 4. Treated dates (69.0% invert sugar) have a 1.3 times higher moisture content than untreated dates (37.3% invert sugar) of almost the same relative humidity. In addition, the pressure required to flatten date pieces under similar conditions, Table 4, shows that treated dates are considerably softer than untreated dates. When whole, pitted dates of the same moisture content were compared, the treated dates were still found to be softer. Thus, Deglets with a high invert sugar content have the advantage of having a relatively softer texture at low moisture levels and of containing appreciably greater amounts of water at the same relative humidity than Deglets with a high sucrose content.

PRACTICAL APPLICATIONS AND CONSIDERATIONS

From the foregoing discussion it is apparent that by varying temperature and moisture and by the use of added invertase the rate of sucrose inversion in Deglet Noor dates can be controlled. The use of high temperatures, high moistures, and added invertase results in the most rapid rate of inversion. By varying the holding time any desired degree of inversion can be attained.

The use to which the dates will be put determines the degree of inversion needed. For instance, a process which brings about a slight degree of inversion might be used to improve the quality of dates that dry prematurely on the tree and have an undesirably firm texture. A process which brings about a moderate degree of inversion might be used to produce dates which are competitive with imported invert variety dates, or a process which brings about a large degree of inversion might be used to produce dates for products use such as a cereal additive.

To bring about inversion in a reasonable length of time the following general procedure is suggested:

1. Hydrate dates to at least 26% moisture
2. Treat with a preservative to prevent microbial growth
3. Hold at 130-140° F. for the length of time required to bring about the desired amount of inversion (see following calculations)
4. Dehydrate to desired final moisture content

The approximate holding time (t), in hours, required to bring about a desired amount of inversion with dates of known moisture content at any temperature can be calculated from the following equation where I is the initial percentage of sucrose, F is the final desired percentage of sucrose, and H is the half-time, in hours, at the moisture content and temperature in question:

$$t = 3.3\ H \log \frac{I}{F}$$

If inversion is conducted at 140° F. the half-time for dates of any moisture content between 14.6% and 31.6% can be read from Fig. 2. If dates of 31.6% moisture are to be inverted Fig. 1 can be used to read the half-time for any holding temperature between 41° F. and 140° F. All dates probably will not undergo sucrose inversion at exactly the same rate as the dates used in this work because of biological and seasonal variations. However, the data reported here show the relative effects

of the important factors influencing the rate of inversion and allow a general estimate of the inversion holding time to be made.

An example seems in order to illustrate the use of the graphs and the above equation in determining the holding time. Suppose that dates of 30% moisture containing 75% sucrose are to be inverted at 140° F. so that the sucrose will be reduced to 35%. The half-time, 18.8 hours, for dates of 30% moisture content at 140° F. is read from Fig. 2. This half-time is employed in the above equation to calculate the holding period:

$$t = 3.3 \text{ H} \log \frac{I}{F}$$

$$t = 3.3\ (18.8) \log \frac{75}{35}$$

$$t = 3.3\ (18.8)\ (.332)$$

$$t = 20.6 \text{ hours}$$

If invertase were added to the fruit the holding period would be shortened. It could be added by suspending the enzyme in the water used in the vacuum infiltration hydration technique. The concentration of enzyme used in the hydration water depends on the amount of water taken up by the dates during hydration. The weight percent of enzyme required in the hydration water can be determined by dividing the weight of water absorbed per 10 pounds of dates into the weight of enzyme desired per 1000 pounds of dates. The amount of crude invertase injected into the dates in the experiment reported above was 0.5 pound per 1000 pounds of dates.

SUMMARY

Deglet Noor dates which have been treated to promote sucrose hydrolysis to the point where they contain about 50% invert sugar have a softer texture and a lower equilibrium relative humidity than untreated Deglets. In addition, they have a pleasing flavor and color. The sucrose of this variety of date can be readily converted to invert sugar by making use of the invertase naturally present in the fruit. Moisture contents above 26% and temperatures of 130 to 140° F. accelerate the inversion reaction markedly. Added yeast invertase also speeds the reaction. A formula and data are given which allow the time of inversion to be calculated for different holding temperatures and for dates of various moisture levels.

The inversion process should find use in improving the quality of dates that dry prematurely on the tree, in producing a date which is competitive with imported invert varieties, and in preparing date products that are soft in texture at low moisture levels, such as a date cereal additive.

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Table 1. Effect of moisture content on rate of sucrose inversion in whole, pitted dates at 140° F.

Moisture	Half-time Observed	Half-time Predicted[1]
percent	hours	
22.1	60.5	65
25.6	34.8	36
27.4	31.9	27
30.8	17.5	17

[1]See text and Fig. 2.

Table 2. Effect of pure invertase on rate of sucrose inversion in whole, pitted dates at 140° F.

Moisture	Half-time Untreated control	Half-time Invertase treated[1]
percent	hours	
22.1	60.5	46.0
30.8	17.5	9.0

[1]2 mg. of invertase per date.

Table 3. Effect of crude invertase on rate of sucrose inversion in whole, pitted dates at 140° F.

Moisture	Half-time Untreated control	Half-time Invertase treated[1]
percent	hours	
27.4	31.9	23.0

[1]5 mg. of invertase per date.

Table 4. Comparison of properties of treated and untreated date pieces.

	Untreated[1]	Treated[2]
Relative humidity, %	41.0	39.5
Moisture content, %	6.23	7.83
Pressure, lbs.	16.3	10.6

[1]37.3% invert sugar.
[2]69.0% invert sugar.

SKIN SEPARATION IN SOFT DATES

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INTRODUCTION

In the final stages of ripening and curing there is usually some separation of skin and flesh, sometimes called blistering, in the fruit of the date palm. It may be very slight and unnoticeable. On the other hand, half or more of the surface of the fruit may be completely separated from the flesh, giving the fruit a balloon-like appearance, and then the skin, which is soft and tender when it adheres to the flesh, tends to become dry and tough and is objectionable to the consumer.

Skin separation is seldom pronounced in the firm or semidry varieties which retain their original shape with relatively little decrease in volume as they ripen, but soft dates which are characterized by considerable shrinkage of flesh are often seriously affected. In some dates, such as the Kustawy, formerly planted to a limited extent in commercial gardens in this country, skin separation is so pronounced as to constitute a serious drawback to planting. In the Barhee variety there is often enough skin separation to cause complaints by handlers.

Little is known about the cause of skin separation. It has been attributed to too rapid loss of moisture, but this is very questionable (2). It is accentuated by fermentation (2), but obviously fermentation is not necessary. Freeman (3) reported that under certain conditions a high incidence of skin separation occurred when dates were ripened off the palm in warm maturation chambers with high humidity. His findings will be considered later. It is apparent that a number of factors may be involved in the production of skin separation, but the idea has persisted among date growers (4) that the amount of skin separation is to a large extent determined by cultural practices and environmental conditions prior to harvest and the experiments reported here were undertaken to explore this possibility.

EXPERIMENTAL METHODS AND RESULTS

Preliminary Survey

In 1959 a survey was made to determine the amount of skin separation occurring on Khdrawy fruit, the principal soft date grown in the United States. Samples of fruit were taken from a number of palms in each of 8 commercial plantings in different parts of Coachella Valley and were graded as to the amount of skin separation just prior to the first picking in late August and early September. The grades were based on an estimate of the percentage of total fruit surface affected by skin separation: less than 25%, slight; 25% to 50%, moderate; more than 50%, severe. The average percentage of fruit affected by severe skin separation in the different gardens varied from about 20 to 30.

Number of strands per bunch

The effect of number of strands on skin separation was studied with 10 pairs of bunches on Khadrawy palms in full production at the U.S. Date Field Station. On July 30 the number of strands on one bunch in each pair was reduced to half that carried by the other. After treatment the average number of strands per bunch was 22.4 versus 40.6. The fruit was all harvested at one time, October 9, after it was all ripe and about 3 or 4 weeks later than a first picking would have been made commercially. The average percentage of fruit affected by severe skin separation was 40.6 for 22.4 strands per bunch and 50.8 for 40.6 strands per bunch. This was a significant difference[1] and because of its bearing on grower practices of bunch thinning it seemed desirable to get further verification.

In 1960 an experiment was set up on a larger scale with Khadrawy palms 25 years of age at the U. S. Date Field Station. Nine palms were used; on each there were two replications of 5 different bunch-thinning treatments; 1—inner strands removed until only 50 per bunch were left; 2—only the outer circle of strands left which averaged about 35 per bunch; 3—similar to 2 but additional strands removed until there were only 20 per bunch; 4—same number of strands as in 2 but 9 inch spreader rings inserted in center of bunch at the beginning of the khalal stage the middle of July; 5—similar to 2 but strands cut back enough to remove about 15% of the fruit. The bunches used for the different treatments were selected at random except that one replication was on the north half of the palm and one on the south half. The average number of dates per strand, as determined a month before harvest, varied from 20.8 to 22.8 for treatments 1 to 4 and was 17.9 for treatment 5. The average set of fruit for the different treatments varied from 43 to 49 percent of the total number of flowers.

The first picking of fruit was made on August 22-23, at which time about half of the crop was harvested. The second picking on September 12-13 completed the harvest. Each bunch was picked separately and a sample of approximately 100 fruits was taken from each lot for grading. Each sample was weighed, graded for amount of skin separation, and the percentage of fruit in each grade determined by counting the individual fruits. The grades were similar to those used in the survey of the previous year and in other studies reported herein. The results[2] of this experiment are shown in Table 1. This table reports average percentages, but analysis of variance was done on angles corresponding to percentages. The Duncan Multiple Range Test was applied to the means.

In the first picking there was a definite trend for the severity of skin separation to decrease as the number of strands decreased with a significant difference between Treatments 1 and 3 and also between Treatments 1 and 5. Except in Treatment 4, results of the second picking are at variance with those of the first; Treatment 1 had the least severe skin separation with significant differences between it and Nos. 2 and 4. Treatment 4, which differed from Treatment 2 only in having spreader rings, had the highest percentage of skin separation in both pickings, but the difference between the two treatments was significant only in the first picking.

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[1]*Student's Method was used to determine the significance of these and subsequent data except those reported in Table 1. Angles corresponding to percentages were used for analysis. A difference is considered significant if the odds against its occurrence by chance are as much as 19:1 and highly significant if as much as 99:1.*

[2]*The writer gratefully acknowledges his indebtedness to Dr. Morris J. Garber, Biometrician of the University of California at Riverside, for suggesting the layout of this experiment and for the statistical analysis of the data.*

Table 1. Percentage of Khadrawy dates with severe skin separation following different bunch-thinning treatments.

Treatment number	Number of strands after thinning	1st picking	2nd picking
1	50	32.4 b*	30.4 a*
2	35 (approx.)	26.4 ab	46.8 b
3	20	23.4 a	35.1 ab
4	35 (+ rings)	40.8 c	48.8 b
5	35 (—15% from tip)	22.4 a	42.2 ab

*Means followed by letter a, b, or c are significantly different (5% level) from those not followed by the same letter.

Number of dates per strand

In the Khadrawy experiment reported in Table 1 no significant difference in skin separation resulted from reducing the number of dates per strand about 15 percent (Treatment 5 as compared with Treatment 3) but this is a very slight reduction. The effect of a much larger reduction in number of dates per strand by cutting back the tips of strands was studied in the Barhee variety in a commercial date garden[3] in the lower end of Coachella Valley.

Twenty bunches were selected — 10 pairs, each pair of approximately the same size, near each other on the same palm and thinned to the same number of strands per bunch. The bunches had already been thinned commercially when the experiment was started and the number of strands was not changed except to have in each pair the same number, which varied between pairs from 29 to 55, with an average of 38.8. On May 31 by cutting back the strands on one bunch of each pair the number of dates per strand was reduced to about half that of the other, the number of dates per strand after thinning being 15.2 as compared with 29.9. The average set was 78%, which is unusually good for this variety. Samples were taken for grading between October 11 and December 7, when enough of the fruit was ripe to warrant picking. This is a wide spread but Barhee is a late-ripening date and there was considerable difference in time of maturity between the different bunches. The results of the grading showed that the average percentage of fruit affected with severe skin separation was 26.3 for the bunches with 29.9 fruits per strands and 47.7 for the bunches with 15.2 fruits per strand. This difference is highly significant.

As this experiment was in a commercial garden, after a sample of ripe fruit was obtained most of the bunches were returned to the owner for picking with the rest of the crop. However, two pairs of bunches, on which not more than 10 or 20 percent of the fruit was ripe when the first sample was obtained on October 11, were retained without further disturbance until November 29, when all the fruit was ripe and well cured. At that time the percentage of fruit affected with severe skin separation was: pair No. 1—long strands 32, short strands 47; pair No. 2—long strands 45, short strands 74. These are differences similar to those obtained earlier.

Moisture content of fruit

An evaluation of the factors that contribute to skin separation is complicated by the fact that skin separation does not occur without drying of the fruit but drying of the fruit may occur without skin separation. Hence, if dates that have been graded for skin separation are subsequently tested for moisture, those with most skin separation will usually have the lowest percentage of moisture and those with the least skin separation the highest. This relation is illustrated in Table 2. However, there will be individual dates in the group with least skin separation which are not different in moisture content from those with most skin separation. Also, since normal ripening is accompanied by a decrease in moisture content, more skin separation will usually be found in the more mature fruit.

Ripening off the palm—on strands

In connection with the field experiments carried out in 1960 the effect of moisture content of fruit on skin separation was studied in relation to other factors. Eight similar strands of Barhee dates were cut when about 2/3 of the fruit was in the khalal stage and the remainder in varying stages of early ripening (Table 3). The cut ends of four of the strands were immediately placed in water; the cut ends of the other 4 were left exposed. Each fruit was graded and numbered with India ink to indicate the grade. The fruit was left exposed on a tray in a large room. One month later the fruit was graded again. There was about twice as much severe skin separation on the fruit on the strands with cut ends in water. The data are insufficient for statistical analysis, but strongly suggest that the internal water supply of the fruit is an important factor in skin separation. All the khalal fruit ripened into soft dates with only a slight tendency for shrivel or excessive drying in a few of the fruits on strands with cut ends exposed. Apparently a reduction in moisture content in the initial stages of ripening favored a reduction in skin separation.

Table 2. Moisture content of Barhee dates in relation to amount of skin separation.

Skin separation	Number of fruits	Average moisture
Less than 25%	38	32.2%
25-50%	25	28.3%
More than 50%	29	25.1%

Table 3. Effect of water supply to detached strands on skin separation of Barhee dates.[1]

Condition September 29		Number of fruits		Severe skin separation October 31—percent	
Maturity	Skin separation	With water	Without water	With water	Without water
All khalal	none	53	65	75	35
Part khalal, part translucent	very slight on some	22	15	55	33
All translucent	slight on some	5	15	80	53
All translucent	moderate on some	7	8	71	38
	Total	87	103	70	38

[1]4 strands with water and 4 without.

Ripening off the palm—off strands

The effect of relative maturity at the time of picking on the subsequent development of skin separation was observed by selecting 3 lots of Khadrawy fruit with no appreciable skin separation and placing them on trays stacked in a packing house for about a month. At the end of this time the fruit was graded for skin separation (Table 4). Of the plump light brown dates with a yellowish cast suggesting transition from the khalal stage 84% had severe skin separation. Of the riper fruit, as indicated by light amber color without a yellowish cast and by softer but still plump flesh, only 30% had severe skin separation. Fruit selected for still more advanced maturity, as indicated by a little deeper color and very slight wrinkling but still no appreciable skin separation, had only 10% of severe skin separation when graded in spite of two weeks longer on the trays.

Possibility of injury from high temperature or high humidity during early development of fruit.

The possibility that skin separation might be affected by high temperatures early in the development

[3]*The writer wishes to express his appreciation to T. R. Brown for cooperating in this experiment.*

of the fruit was suggested by Rygg's studies (11) which have shown that a high percentage of dry-textured Deglet Noor fruit has been produced in years when high temperatures occurred in the second half of April or in May. On 10 different bunches on Khadrawy palms in full production 4 strands were enclosed in brown paper bags from May 26 to June 13. It has been shown that temperatures surrounding the fruit may be raised in this way and could be sufficiently high to cause injury (10). It is also possible that high humidity within the bags was a factor. On September 24 the fruit on the strands that had been covered was compared with that on four similar untreated strands on the same bunches, each lot being graded for skin separation. The average percentage of severe skin separation of the fruit that had been bagged was 32.6 and that of the untreated fruit 19.0. This highly significant difference indicates that high temperature or high humidity, or both, at an early stage in the development of the fruit may also increase the amount of skin separation in soft dates.

Table 4. Effect of tray drying at room temperature on skin separation of Khadrawy dates of different initial stages of maturity.[1]

Lot number	Condition of fruit before drying	Number of fruits	Percentage of fruit with varying degrees of skin separation after drying: slight	moderate	severe
1	Plump, light yellowish brown, on skin separation	143	3	13	84
2	Plump, light amber, no skin separation	64	42	28	30
3	Very slightly wrinkled, amber, little or no skin separation	144	77	13	10

[1]Fruit dried from September 14 to October 12 except for lot 3 which was put on trays August 29.

DISCUSSION

In the experiments reported skin separation was decreased by reducing the number of strands and increased by severe cutting back of strands. When the number of strands was reduced, however, the effect did not persist beyond the first picking, which might be explained by the greater exposure and more rapid drying following the removal of about half of the fruit from the bunch. This is suggested by the fact that the treatment with strands separated by wire spreaders had consistently the highest percentage of severe skin separation in both pickings.

Thinning by reducing the number of fruits per bunch in any way would be expected to accelerate ripening (9) and thus cause earlier development of skin separation. Nevertheless in the Khadrawy experiment reducing the number of strands reduced skin separation. Acceleration of ripening was most marked as a result of the drastic cutting back of the tips of strands in the experiment with Barhee. The difference in time of ripening between some of the paired bunches in this experiment was so great that the sample from the long strand bunch was taken two or three weeks later than that from the short strand bunch in an effort to obtain fruit in comparable stages of maturity. It seemed unlikely that differences in exposure or in maturity could account for all the differences in skin separation between the different treatments; some were too large and, in the case of Barhee, were shown to persist after all the fruit was well cured.

Observations on the behavior of fruit under varying conditions after removal from the palm suggest that, although skin separation does not become pronounced and objectionable until after the fruit is fully mature and has dried considerably, it begins at an early stage in ripening and that an explanation for it may be found in moisture conditions within the fruit.

It has been shown that checking, or the rupture of cells at and near the surface of date fruit, is caused by excessive turgor just before the khalal stage (1). This excessive turgor builds up when water movement into the fruit exceeds the loss of water by transpiration. Under field conditions high atmospheric humidity, which retards transpiration from both fruit and leaves, brings about such a situation provided the palm tissues are well supplied with water. The results obtained with Barhee fruit on detached strands suggest that a somewhat similar condition occurring a little later in the development of the fruit could account for the initiation of skin separation in soft dates. About twice as much skin separation occurred on the strands supplied with water as on the others. The strands to which no water was supplied may actually have taken moisture from the fruit to replace that lost by transpiration from the strand surface. If so, this would still further have reduced turgor in the fruit.

The ripening of most soft dates begins at the tip and outer part of the fruit and progresses toward the base and center. What seems to happen is that in the initial stage of ripening when the peripheral tissue is just beginning to soften, a build-up of subepidermal pressure, instead of causing rupture in the skin and outer cells, produces a break between the skin and the tissue beneath, which is now softer than the relatively tough skin or the still hard flesh of the fruit nearer the center. This break can often be seen in the early stages of ripening of soft dates and before an air space develops between the skin and the flesh the separated area may be filled with a watery fluid. Long (8) has shown that when the khalal color fades and the fruit begins to soften in the final stage of ripening cell walls are weakened, apparently as a result of hydrolysis.

Moisture determinations indicate that there is a pressure gradient within the fruit increasing from the inner flesh toward the skin. The moisture content of the flesh in the interior of the fruit was higher than that of the mobile fluid between the flesh and the skin in 13 determinations with Barhee dates—an average difference of 0.85%. The conditions accompany the initiation of skin separation suggest that an increase in this pressure gradient is associated with it. As dehydration progresses the skin becomes drier and harder and does not readily retract when the subepidermal liquid disappears.

The Khadrawy fruit dried on trays was carefully selected as to maturity and the absence of any visible skin separation. Lot 1 was at the initial stage of peripheral softening when most skin separation probably begins. In this fruit with a very high moisture content a continuation of water movement from interior to peripheral cells apparently continued long enough to build up enough pressure to cause a break between skin and flesh. Lots 2 and 3 of the Khadrawy represented progressively more advanced stages of maturity and a marked decrease in the amount of skin separation occurred. Most of the fruit in Lot 3 had probably passed the stage when skin separation is initiated for the fruit was subjected to the same conditions of drying as the other lots. These observations on the occurrence of skin separation in fruit ripened on trays are substantiated by Hilgeman and Smith (7), who, on the basis of maturation and storage experiments with soft dates in Arizona, reported that "the skin of dates which have been picked at the fully translucent or hard-ripe stage has a tendency to separate from the flesh; this

tendency is not present in the soft-ripe fruit."

Of special interest in considering the cause of skin separation is the experience of Freeman (3), who worked in Arizona at an earlier period. He used an oven at a temperature of about 122° F. for ripening dates after they began to show some translucence. For treatment in the oven the fruit was placed in graniteware pans with tightly fitted metal covers which provided high humidity during the process. When this fruit was dried afterward an excessive amount of skin separation developed. Freeman reported that skin separation could be prevented if the fruit was given a preliminary drying of 24 to 36 hours when first placed in the oven. The drying was accomplished merely by leaving off the covers of the trays which exposed the fruit to hot dry air ,presumably at the temperature maintained later. After wrinkling appeared the covers were replaced so that ripening could continue at high humidity. On the basis of his experience Freeman concluded that "when the date begins to shrivel in the early part of the ripening process, the skin will continue to cling to the flesh."

More detailed data would help in evaluating Freeman's experiments, but the results seem to confirm the hypothesis that skin separation may be induced by fruit turgor just under the skin at the time the flesh in that region begins to soften. High temperature and high humidity would increase internal pressure in the fruit. A decrease in the moisture content of the peripheral layers of the fruit immediately before softening begins might be expected to increase cohesion between the skin and the adjacent tissues below and if any pressure developed after subsequent ripening it could be absorbed by the interior layers which have then become softer.

This hypothesis helps to explain some of the increase in skin separation that occurred in the Khadrawy experiment after the first picking. The removal of a large proportion of the fruit from the bunch would increase the moisture available for the remaining fruit and thus contribute to an increase in turgor during the initial stage of ripening.

The striking increase in skin separation of Barhee fruit on detached strands supplied with water may be explained by turgor in the initial stage of ripening, but considerable skin separation occurred in fruit on the strands not supplied with water. Some fruits may be more susceptible than others to skin separation, which could be induced with less tension. This greater susceptibility to skin separation could be due to inherent differences in the peripheral tissue. Some variations would be expected among individual dates on any given bunch. But the increased skin separation from enclosing Khadrawy dates in bags in late May and early June suggests also that adverse environmental conditions at an earlier period in the development of the fruit may alter the peripheral tissue in such a way as to increase susceptibility to skin separation. High temperatures or high humidity, or both, might be involved. Even without bagging, fruit on the outer part of some bunches would be exposed to higher temperatures and that in the interior, at least of large bunches, to higher relative humidity than other fruit on the same bunch. High temperatures might harden the skin, reduce stomatal activity, and thus later increase turgor in the fruit. High humidity by checking transpiration might build up internal pressure sufficient to cause damage to subepidermal tissue, perhaps rupturing cells just under the skin, forming a line of cleavage easily separable later as a result of high turgor or merely of shrinkage of flesh.

Differences in the amount of skin separation characteristic of different varieties, as previously mentioned, suggest that differences in structure and composition of skin and fruit tissue are factors involved. In this connection Hilgeman (6) reports that among several varieties of soft dates compared as to the crude fat content of the skin the lowest percentage was in those which have been observed to be affected least by skin separation. A high crude fat content of the skin might be associated with lower transpiration or with a thicker skin which would resist retraction during flesh shrinkage.

In view of the effects of different thinning practices on skin separation the grower of soft dates who is concerned about this problem would be well advised to do most of his fruit thinning by removing entire strands rather than by cutting back strands. In light of the apparent relation between skin separation and water supply to the fruit it is possible that excessive soil moisture in the early stages of ripening may be a contributing factor, but this must be confirmed by further investigation.

SUMMARY

Experiments with soft varieties of dates indicate that within certain limits reducing the number of strands per bunch in fruit thinning tends to reduce the amount of skin separation in ripe fruit, whereas severe cutting back of the strands tends to increase it. Experimental data and observations during ripening suggest that skin separation may be induced by excessive turgor in peripheral tissue just as the fruit begins to soften. There is also some evidence that high temperature or high humidity, or both, may damage or weaken the peripheral tissue at an earlier stage in the development of the fruit and predispose it to skin separation.

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QUALITY OF DEGLET NOOR DATES IN RELATION TO FREQUENCY OF PICKING

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In the summer of 1960 the Date Administrative Committee asked the U. S. Date Field Station to cooperate with two packing houses in Coachella Valley, California Date Growers' Association and Valley Date Gardens, Inc., in studying the effect on grades of Deglet Noor dates of harvesting all fruit at one time as compared with the current practice of making 2 or 3 pickings.

Furr and Armstrong (1) conducted a similar study involving only one garden in which no top grade fruit was produced in 3 of 4 years and frequent pickings were of no advantage. Rygg (2) reported an increase in percentage of dry dates from pickings only 2 or 3 times instead of about 5 which was the usual practice prior to World War II.

It was considered desirable to obtain information from gardens in several locations handled by commercial picking crews. Such information is needed as a basis for anticipating what may happen if scarcity of labor leaves the grower no choice but a single picking or if mechanization of all or part of the operation makes a single picking economically desirable.

Experimental Procedure

Representative gardens of palms in full production were selected in different parts of Coachella Valley—one in the Oasis district (garden A), one in the Palm Desert district (garden C), and one in between (garden B). In each garden 20 palms of approximately the same size and condition were selected, 10 in one row to be harvested in the usual 2 or 3 pickings and 10 in an adjacent row to be harvested at the last regular picking. The palms were paired for the two treatments. Fruit from each palm was picked and sampled separately. All samples were graded by the California Date Growers' Association in the same way as other lots of fruit delivered to the packing house—the grading that determines grower payments. Field operations were under the supervision of the packing house; the grade records were turned over to us for evaluation.

The dates of the completion of the different pickings and the percentage of fruit in each picking (where more than one) were as follows: garden A, Oct. 7 (70%), Nov. 10 (30%); garden B, Sept. 23 (57%), Nov. 2 (43%); garden C, Nov. 14 (39%), Jan. 6 (38%), Feb. 14 (23%). In garden A the palms from which the fruit was harvested at one time were not picked until Nov. 29, although the last regular picking of the other palms was Nov. 10.

Results and Discussion

The effect of number of pickings on grade of fruit is shown in Table 1, in which the percentages are based on the total amount of fruit delivered to the packing house exclusive of field culls. The chief result of harvesting the crop in one picking was to increase the percentage of dry fruit. In all 3 gardens the percentages of top natural and select natural fruit from palms picked 2 or 3 times were significantly higher than those from palms picked once. Likewise the percentages of fruit in semidry and standard dry grades from palms picked only once were higher than those from palms picked 2 or 3 times, but the differences were significant only in gardens A and C. The percentage of culls tended to be higher in the single picking, but the difference was significant only in the hidden culls in garden B and visible culls in garden C.

Table 1. Effect of number of pickings on grade of Deglet Noor fruit.[1]

Garden	A		B		C	
Number of pickings	2	1	2	1	3	1
Top natural, %	3.3*	1.5*	2.5*	0	9.3*	0.4*
Select natural, %	11.7*	3.7*	13.1*	0.8*	23.4*	12.4*
Semidry, %	61.3*	69.7*	63.6	66.1	52.4*	65.7*
Standard dry, %	16.8	17.5	15.3	25.9	9.2	12.7
Substandard, %	0.3	0.6	0.9	1.2	0	0
Culls, visible, %	3.7	5.1	2.1	2.4	4.7*	7.3*
Culls, hidden, %	2.9	1.9	2.5*	4.1*	0.9	1.5

*Difference between means significant at odds not less than 19:1.

[1]Average of 10 palms, picked fruit only.

Table 2. Yield of Deglet Noor palms in relation to field culls and number of pickings.[1]

Garden	B		C	
Number of pickings	2	1	3	1
Total pick, lbs.	2090	1565	3035	2490
Field culls, lbs.	957	1360	839	650
Total yield, lbs.	3047	2925	3874	3140
Field culls, %	31.4	46.5	21.7	20.7

[1]Total of 10 palms.

Total yields of the 10 palms in each treatment of gardens B and C, including field culls are shown in Table 2. Garden A is not included because field culls were not recorded. Picked fruit in this garden totaled 2842 lbs. from the 10 palms harvested at one time and 2639 lbs. from the 10 palms harvested in two pickings.

Because of large variations between individual palms differences in yield were not statistically significant in any of the gardens. However, the significant increase in percentage of the drier, and consequently lighter, fruit in the single picking leaves little doubt that single picking affects the total weight of fruit harvested and would probably cause an appreciable difference with a larger number of uniform palms.

The percentage of field culls in garden C was approximately the same as that reported for the entire Coachella Valley in the 1960 crop report of the Riverside County Agricultural Commissioner. Furthermore, the field culls in garden C were distributed somewhat proportionately in the different pickings: 42% in the 1st, 32% in the 2nd, and 26% in the 3rd. In garden B in the single picking there were almost as many field culls as picked fruit, 46% of the total yield. The percentage of field culls was less when two pickings were made, but 31% is still high. Of the total field culls harvested in two picks in garden B, 71% was in the second picking, although only 43% of the total picked fruit was harvested in this picking. The high percentage of field culls in garden B is explained in part by the failure of the picking crew to

use a canvas or ground cover so that good dropped fruit could be retrieved as was done in garden C. The fruit harvested in one picking was very dry and shattered easily.

Conclusions

Under present conditions the grower will benefit from more than one picking. If one assumes a return per pound of 14.5c for top natural, 10c for select natural and semi-dry, and 5c for standard dry, and compares equal weights of fruit from each treatment, the increased returns per thousand pounds from more than 1 picking would be $1.86 in garden A, $8.13 in garden B, and $8.86 in garden C. This estimate takes no account of the decrease in weight of fruit held for one picking, a loss which would tend to increase the difference in favor of more than one picking.

Although at present the date grower is not penalized for the extra number of pickings, some saving would undoubtedly be effected by picking only once and if even part of the picking operation can be mechanized there might be still more saving.

Weather conditions during the harvest period will, of course, be an important factor in determining the optimum time and number of pickings. The 1960-61 season rated as fairly good. In spite of late summer showers in some parts of Coachella Valley there was relatively little rain damage, but rain with prolonged high humidity may necessitate extra picking to avoid heavy loss.

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ARE SUPPLIES AND SALES IN BALANCE?

By Billy J. Peightal

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INTRODUCTION

A few years ago at a meeting of the Date Growers' Institute I spoke of the need to expand sales in order to achieve a long run balance between supplies and sales. The alternative would be to reduce excess production—an approach which did not seem sound. It certainly was not attractive.

It was indicated that while a functioning Marketing Order generally did not sell a commodity, it could create a climate conducive to greater sales. With the Date Marketing Order, several approaches to the problem were initiated. Minimum quality requirements for packaged dates were established. Research programs relating to product improvement and toward more efficient marketing were originated. Of great importance, the crop was allocated among outlets so as to bring about conditions of orderly marketing.

The above approaches and more —such as the diversion payment programs and the school lunch program —were enlisted as means of expanding sales and thereby equating supplies and sales over the long run.

How successful have we been in our long run objective? If we have not achieved a balance between supplies and sales, have we made progress in this direction? These are the questions I will attempt to answer.

REVIEW OF DATA

Supply, sales, and carryout data are presented in Table I on an annual basis and in Table II in three year periods. From the information in the tables, background can be developed.

It is to be noted that the supply of dates in any given year consists of free and restricted dates and date products held over from the preceding year together with the quantity of dates produced in that year. Together, these amounts constitute the supply which is either sold or carried over to the following year. Over the period of years under consideration, it can be seen that the total supply of dates tended to increase. This was due primarily to larger carryins, since the production of dates actually reveals little or no trend from the average of 35,000,000 pounds.

Total date sales increased from 28.3 million pounds during 1955-56 to an estimated 38.7 million pounds in this current crop year. These increased sales are due largely to the outstanding growth in date product sales from the beginning figure of 5.1 million pounds to an estimate this year of 12 million pounds. It is unfortunate that data reflecting product sales prior to 1955 are not available, but it is my understanding that they were about 3 million pounds or less.

The 12 million pounds current estimate of product sales will undoubtedly materialize — they may be greater. The level of sales is due to normal growth, a school lunch program which utilized about 2 million pounds, and to some large new accounts.

Sales of free dates show some growth over the period, but not at the rate nor magnitude of product sales. The data fails to reveal, however, that the market was strengthening over the entire period. This is a matter of considerable importance—it is an attribute of orderly marketing.

At this time an analysis of the carryout data will not be made except to mention that for the three year period beginning with 1956 the carryout of restricted dates and date products was greater than the carryout of free dates. This build-up occurred during the period of the development of date products and date product outlets. During 1959 and 1960, however, we see that the carryout of restricted dates and products is less than the carryout of free dates.

It is apparent from the data that sales have increased and that they have increased at a remarkable rate. The data does not reveal that this growth of sales, largely in products, has had the effect of strengthening the entire market—particularly, the market for free dates. In this respect, progress toward the stated objectives of the Order can be recorded.

PRODUCTION vs. SALES

Now that we have reviewed the supply and sales data, we can raise the question as to the matter of balance between the two. When we speak of supply in this sense, we actually think of production since over time it is the real supply. What we are really trying to determine then is whether current and expected sales are in balance with the normal production of dates. It also seems appropriate to look at the relationship of past sales with this production.

First, I should like to consider the average of handler receipts over the six year period as being the normal supply primarily for three reasons—one, the bearing acreage did not change materially over this period; two, it is not expected that large changes in acreage will occur soon; and three, while a more refined method of computing "normal supply" could be employed, it is doubtful that the conclusions would be much different. When we follow this procedure, we then place the normal supply of dates at 35 million pounds. Obviously there will be years when production will be greater than this amount, and years when production will fall below. Over a period of

time, however, it seems reasonable to expect a normal supply of 35 million pounds.

From Table 3 can be ascertained in a general way the degree of balance between supplies and sales currently, and also during the first years of the Order by comparing sales in the two periods with the average production of 35 million pounds.

In the first period, the crop years of 1955 through 1957, sales averaged 30.2 million pounds compared with the normal production or supply of 35 million pounds. It appears that sales were less than normal supply by 4.8 million pounds or 13.7%. This portrays that which most of us could sense, that there was a tremendous imbalance between supply and sales. It indicates, too, the need at that time to concentrate on developing additional outlets. There were many problems during this period, as you know, and they largely were created by this imbalance.

The average of sales in the second period closely approximates the level of normal supply. Therefore, it does appear that supplies and sales finally have approached a balanced condition. We can attribute this mostly to the amazing growth in date product sales.

It does seem that in a broad sense supplies and sales are in balance. Can we expect this to continue over time? We know, of course, that annual fluctuations in production can be expected, and these fluctuations may cause an imbalance for short periods. Broadly speaking, however, it would seem that the balance can be maintained—at least for the next few years. Any apparent long term production changes during that time would occur at a rate permitting appropriate adjustments in the marketing program.

FUTURE CONSIDERATIONS

With the information we have it is indicated that supplies and sales are in balance to the extent, at least, that burdensome excesses do not now appear to exist. Thus, one of the main objectives of the industry apparently has been achieved. It was due primarily to the growth of product sales. It appears now that our efforts need to be directed toward increasing the quantity of dates sold in the free date outlet, for it is that outlet which yields the largest net returns to growers. Further, we finally can squarely face the problem having developed most of the basic conditions conducive to sound growth in that outlet.

When we look at the quantity of free dates sold, it is noticed that it has increased only a small amount. Since the population has grown at a substantial rate, sales of free dates, then, on a relative basis actually are decreasing. This situation must change if the industry itself is to grow.

Now that an improved marketing picture is being realized, increased free date sales will materialize, in my opinion, largely when the quality of dates offered for sale substantially improves. It appears now that the current division of sales between the free date outlet and the product date outlet actually reflects the division between dates of package quality and dates which are not. Quality mostly is the responsibility of growers and they should recognize it as such. It is a responsibility that cannot be ignored nor minimized.

The direction toward which this industry must proceed is clear enough. Continued diligence and work will be required to achieve the necessary goals. Judging from the way the industry responded to the challenge six years ago, I have every confidence that this industry successfully will meet this current challenge and any the future may hold.

Table 1. Marketable dates: supply, sales, and carryout, 1955-56 to date.

	Crop Year Beginning August 1						
	1955	1956	1957	1958	1959	Est. 1960	Avg.
	—mil. lbs. equiv. whole dates—						
SUPPLY							
Carryin	2.2	13.0	13.5	19.8	14.1	20.4	13.8
Handler Receipts	39.1	32.2	36.8	27.6	40.8	33.1	35.0
Total	41.3	45.2	50.3	47.4	54.9	53.5	48.8
SALES							
Free Dates	23.2	25.5	24.2	24.7	25.5	26.7	25.0
Date Products	5.1	6.2	6.3	8.6	9.0	12.0	7.8
Total	28.3	31.7	30.5	33.3	34.5	38.7	32.8
CARRYOUT							
Free Dates	10.0	4.2	6.8	5.1	10.9	8.3	7.6
Restricted Dates Products	3.0	9.3	13.0	9.0	9.5	6.5	8.4
Total	13.0	13.5	19.8	14.1	20.4	14.8	16.0

Table 2. Marketable dates: supply, sales and carryout, three year periods.

	Crop Year Beginning August 1 —mil. lbs. equiv. whole dates—		
	1955-57 Avg.	1958-60 Avg.	Avg. All
SUPPLY			
Carryin	9.6	18.1	13.8
Handler Receipts	36.0	33.8	35.0
Total	45:6	51.9	48.8
SALES			
Free Dates	24.3	25.6	25.0
Date Products	5.9	9.9	7.8
Total	30.2	35.5	32.8
CARRYOUT			
Free Dates	7.0	8.1	7.6
Date Products	8.4	8.3	8.4
Total	15.4	16.4	16.0

Table 3. Excess supply; three year periods

	Crop Year Beginning August 1 —mil. lbs. equiv. whole dates—		
	1955-57 Avg.	1958-60 Avg.	Avg. All
SUPPLY			
Carryin	9.6	18.1	13.8
Handler Receipts	36.0	33.8	35.0
Total	45.6	51.9	48.8
SALES			
Free Dates	24.3	25.6	25.0
Date Products	5.9	9.9	7.8
Total	30.2	35.5	32.8
CARRYOUT			
Free Dates	7.0	8.1	7.6
Date Products	8.4	8.3	8.4
Total	15.4	16.4	16.0
Excess—lbs.	4.8	—.5	
%	13.7	..	

1960 RESULTS USING NEW INSECTICIDES AND METHODS FOR THE CONTROL OF DATE INSECTS AND MITES

H. S. Elmer

University of California Citrus Experiment Station, Riverside

Investigations on the control of date insects and mites have been conducted in the Coachella Valley area of southern California by the Department of Entomology of the University of California Citrus Experiment Station since 1948. During 1960, this project was turned over to the author and investigations initiated by D. L. Lindgren and L. E. Vincent were continued in 1960, a year when mite populations were quite severe in many date gardens. These pests include the Banks grass mite, *Oligonychus pratensis* (Banks), formerly called the date mite, and the nitidulid beetles infesting dates, mainly the corn sap beetle, *Carpophilus dimidiatus* (Fab.), the dried fruit beetle, *C. hemipterus* (L.), the pineapple beetle, *Urophorus humeralis (Fab.)*, and the yellowish nitidulid, *Haptoncus luteolus* (Er.).

Mite Control

Initially mite control tests were designed to duplicate past work using some new acaracide dusts that had not been evaluated in comparison to sulfur dust. Observations were also made on the effectiveness of commercial sulfur dust to large acreages. These observations revealed that poor control of date mites using sulfur dusts was often correlated with inadequate coverage with these dusts. Vincent and Lindgren (1958) point out that best mite control was obtained by blowing the sulfur dust directly upward into the bunches. Poor coverage with sulfur dust results when either the equipment is incapable of blowing the dust to the high date bunches, or when wind prevented the dust from reaching these heights. Dusting sulfur is also more irritating to the eyes of the dust applicator and personnel working in the trees after application than wettable sulfur. These factors limiting the effectiveness of dusts suggested that sulfur and other acaracides and even insecticides might be applied as sprays. A spray program was therefore initiated using wettable sulfur and wettable powder acaracides during the time that mites were still doing damage to the fruit.

Sprays were applied with conventional high pressure ground citrus sprayer using a shade tree gun which is usually capable of reaching the height of the tallest bunches from the ground. The bunches were thoroughly drenched with the spray at the rate of approximately one gallon per bunch. The results of these preliminary spray tests are shown in table 1 along with the results of earlier dust applications using a rotary hand duster at the rate of approximately one pound per date bunch. All materials were applied to low growing date palms to facilitate observation and each treatment was replicated three times.

Table 1. Comparison of results of acaricides applied as dusts and sprays for the control of Banks grass mite.

Acaracide[1]	Percent Active Ingredient	Days[2] Effective
Dusts Applied June 6, 1960		
Sulfur	98	41
Kelthane	5	30-41
Tedion	5	30-75
Trithion	5	35
Ethion	5	20-28
SG-68[3]	100	0
Pyrophyllite[4]	100	0
untreated	—	0
Sprays Applied July 20, 1960	**Lbs./100 Gals.**	
Sulfur	4	31
Kelthane	1.5 (18.5% WP)	31
Tedion	1 (25% WP)	31
Eradex[5]	1 (50% WP)	31
Water	..	0
untreated	..	0

[1]Eradex, Kelthane, Tedion, Trithion and Ethion residue tolerances on dates have not been established.

[2]Minimum to maximum number of days plots were free of mite infestation.

[3]Silica aerogel.

[4]Pyrophyllite—inert dust diluent.

[5]2,3-Quinoxalinedithiol cyclic trithiocarbonate.

The number of days dusts were effective was quite variable even with a given acaracide as evidenced by Tedion results. This was probably due to inadequate coverage as only two of the bunches in one plot became reinfested as early as 30 days while one plot remained free of mites for the duration of the observations, or 75 days. Pyrophyllite was used as a carrier for the Kelthane, Tedion, Trithion and ethion dusts. Pyrophyllite alone and silica aerogel gave no control. The plots were abandoned in mid-August because it was believed no injury would occur from mites after that time. All of the sprayed plots were free of mites until mid-August but just prior to picking in November all of the treated plots became reinfested and considerable injury resulted. Further tests are necessary using these materials as both dusts and sprays to substantiate this preliminary data. Some large acreages will be sprayed with wettable sulfur this year as soon as mites appear in May and mite populations observed until the dates are picked.

The Banks grass mite persists in date gardens through the winter on the white tissue of the leaf bases and on grass (Lindgren & Vincent 1949). This mite does not travel from place to place by spinning and floating on the wind as do some species of spider mites and so it was hoped that elimination of mites from date gardens at a time when the populations were low might prevent infestations on the fruit or at least retard their reappearance.

Wettable sulfur or wettable sulfur and oil combinations have been sprayed on various plots in January, February, and March. Wettable sulfur was used at the rate of 4 pounds per 100 gallons of water alone or in combination with 2 quarts of light medium oil emulsion. The whole tree was sprayed as well as the grass surrounding the date palm. Observations have been made on phytotoxic injury to the trees. To date no injury has resulted. These observations will be continued through the fruit bearing season along with mite population counts and fruit yield determinations.

Nitidulid Beetle Control

Nitidulid beetle control experiments consisted of insecticide dusts

Table 2. Effect of dust treatments in seven replicated plots on the infestation of Deglet Noor dates by Nitidulid beetles in 1960.

Treatment	% Beetle Infested Dates at Harvest Per Replication[2] 1	2	3	4	5	6	7	Average
5% Malathion	0	0	0	0.2	0.2	0	0.7	0.16
5% Diazinon	0.6	0	1.1	0.7	0	1.1	0.9	0.63
5% Sevin	1.1	0.1	0.9	1.0	0.1	1.0	0.1	0.60
untreated	....	....	....	....	....	....	....	6.90

[1]Diazinon and Sevin residue tolerances on dates have not been established.

[2]Based on a 3 pound date sample per replication.

containing Sevin and Diazinon in comparison with malathion dusts. The number of beetles present was not statistically evaluated until harvest time although observations were made in the field from September 15 until all the dates were picked. These results are reported in table 2.

All three dusts gave adequate control on these tests.

The experimental program for evaluation of new insecticides applied as dusts for control of nitidulid beetles will be expanded in 1961. Experiments with insecticide sprays will also be initiated in 1961. Sprays have not been used because of the danger of date spoilage, however, it may be that applications made at a time evaporation rate is high will not increase this danger of spoilage.

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OBSERVATIONS ON DATE PACKING IN IRAN

By E. J. Codekas

Date Grower, recently with Stanford Research Institute

I was recruited by Stanford Research Institute in August of 1959 to operate a date packing plant in Khorramshahr, Iran. This modern packing plant had been built over a 5-year period with joint funds supplied by both the Iranian and United States governments and well over a million dollars had been spent on the project.

Stanford Research Institute had a contract with the Seven Year Plan Organization of Iran, but the funds for this technical advice were provided by the United States Overseas Mission and naturally some confusion resulted in dealing with two government agencies. The date plant had been originally conceived by USOM. However, the project got out of hand and when USOM finally realized that they did not have the qualified technicians available to run the plant the project was turned over to S.R.I. to complete. By this time it had grown from a simple demonstration project into a full-sized commercial plant and the problems had multiplied almost as fast as the folders in the filing cabinets.

The conception of having a modern date plant in this area was good. The original thinking of setting up a small demonstration project was sound, but somewhere in the bureaucratic bog of USOM the project changed from a demonstration plant that could have been completed for less than $100,000 to a full-sized commercial plant that has cost over one million dollars and is still incomplete.

Conditions in the Iranian date industry are so incredibly squalid, primitive, and filthy that some sort of assistance program was desirable. However, you can imagine my astonishment upon my arrival in Khorramshahr in October 1959 when I found out that the local packers were not interested in this modern plant but actually opposed it.

Khorramshahr is a small town that straddles the Karun river in Southern Iran just across the border from Basra, Iraq. Historically, 90% of the imported dates have come from Iraq. However, during the previous 3 years the Iraqi industry had suffered from the effects of nationalization and political strife and date importers have looked to Iran as a possible source of supply.

The main export variety of Iran is the Sayer, which is a nice date, easy to handle both in the field and in the plant. It resembles the Halawi in size and shape but is stronger in flavor and darker in color. Date culture in this area has changed little in the last thousand years. The dates are usually pollinated only once and then left alone until picking. They are not dethorned, dusted, thinned, tied down, or bagged. At harvest time the whole bunch is cut and dropped to the ground. The dates are shaken off into boxes or just into piles on the ground if boxes are not available.

One natural advantage of this area is the system of tidal irrigation. The date groves line the banks of the river and as the tide comes in the river backs up into irrigation channels and the palms are irrigated twice daily by this tidal action. The better gardens produce 10,000 lbs. to 12,000 lbs. of dates per acre, although many gardens are very neglected and do not average half of this tonnage.

During the summer I noticed that most of the gardens had a terrific infestation of mite and I honestly expected that 50% of the crop would be lost. Apparently the Sayer variety is rather resistant to mite because at picking time mite damage proved to be negligible. The web seems to come off the date very easily during handling and once packed the mite damage is unnoticeable.

The infestation of dates with fruit beetles was unbelievably low last season. One reason for this is the fact that no dates are allowed to remain on the ground to rot. All windfalls are immediately consumed either by the grower or his animals and since the area is quite windy any bad dates in the bunch fall to the ground where they are immediately disposed of.

I arrived in Iran in late October 1959 and spent the next 8 months in getting the plant ready for the 1960 harvest. This included putting in a water filtration system, fumigators, and many other small but time-consuming jobs. Actually, all of this work could have been completed within two months but the job was constantly interrupted by lack of funds. Our payroll ran from two to four months late and at times we were so short of funds that we couldn't even buy gasoline for the gas engine-driven arc welder. This lack of any sort of dependable budget was very frustrating, especially since thousands of dollars were siphoned out of our funds and used to complete an elaborate garden and landscaping project that admittedly beautified the plant but added nothing to the practical features.

The lack of funds was the most serious problem, but the language barrier was also a handicap. Although Farsi (Persian) is the official language of Iran, the southern part of Iran is mostly Arabic and all of the workers speak only Arabic. My Iranian counterpart spoke only Farsi and English so that my English had to be translated into Farsi, then from Farsi to Arabic and any communication from the workers had to come back the same route in reverse. This added to the general confusion.

The highpoint of my stay in Iran was when V. H. W. Dowson arrived late in August of 1960 and I spent a most interesting and fruitful week out in the gardens with him. Dowson speaks fluent Arabic, is a very competent and dedicated person and I learned more from the time I spent with him than I had in the previous 10 months. I was fortunate enough to see Dowson again in the spring of 1961 just before I left Iran. Dowson is making a study of the varieties

and available supplies in the different date growing areas of Iran and had discovered a seedless date in one of the remote regions. I hope that it will be possible for him to report on this to a future Date Growers Institute.

After months of constant pleading, cajoling and report writing we finally had the plant ready for operation and began receiving dates in September of 1960. We received over 550 tons of dates and made an actual commercial run, packing out the fruit in bulk 50 and 70 pound containers. The dates were graded into 4 grades—Select, General Average Quality (G.A.Q.), Number 2, and culls. The crop was one of the finest in living memory and I was impressed by its excellent quality. Unfortunately, no attempt is made to retain the quality once the crop is picked and the dates suffer a terrific beating between the gardens and the plant. Field boxes are in short supply and the growers actually stamp the dates into them so that some of the boxes must be ripped apart to get the dates out. These solid blocks of dates were not suitable for a modern plant operation so we were forced to install a special belt before the washer and used up to 14 men on it to break the lumps of dates back into individual units.

Our wage rates were unbelievably low. The pitters received less than 3 cents per hour, graders around 4 cents per hour and the men received about 8 cents per hour. Over 80% of our pitting crew of 300 workers was under 12 years old and the employment of these children bothered me until I realized that they were generally better off in this airy, modern plant than at home. Most of the workers are nomads who are exploited by the packers.

The packers have had an excellent return on their investment for the past few years. The packers buy the dates for less than 2 cents a pound and last year received 7¼ cents per pound for the average quality and 9 cents per pound for the select grade F.O.B. Khorramshahr. Even the pits are bagged and sold; most of them are shipped to Kuwait in gunny sacks where they are used as cattle feed.

The Iranian date packers have such a low overhead and low wage rate that they have made no improvements in packing over the last hundred years. Most of the crop is packed in open sheds without screens or proper toilet facilities. Open sewers run alongside these sheds and the fly problem is terrific. All of the pitting is done on a piecework basis and since the women can work faster by using their teeth instead of a knife, this method is used extensively. The large sheds provide knives for the women and make sure that the knife is employed when visitors are present. A great portion of the pitting is done out in the field or homes by families without any supervision and this is usually done using the tooth method.

Two high speed mechanical pitters (Ashlock) were received and installed in the government plant in November 1960. A trial run showed that these pitters will work on the Sayer date if it has been properly handled. The main problem in machine pitting was the fact that almost all of the dates were flattened and distorted by improper handling and although the dates would run through the pitter, the pitter would miss the pit completely. This problem would be solved if more field boxes were available and if more care were exercised in harvesting the crop. A properly handled lot of dates would be pitted without any trouble.

My experience in Iran was very interesting and frustrating. My whole view of the U. S. Foreign Aid program has changed after seeing it in action for over 17 months. I went to Iran thinking that our Foreign Aid program, while costly, was worthwhile. Now I feel it is only costly. This date plant was so mismanaged from the very beginning that we not only failed to provide goodwill for the vast sum spent but we actually created resentment among people because of this project. And this is not an isolated instance. There are at least half a dozen other food processing projects including canneries and raisin packing plants in Iran that have just the same history and results. The Iranian industry has the money to modernize itself without outside aid. The Iranian packers only resented our efforts to show them how to handle a product that has been profitable under their own methods. The Iranian packer has to compete with other date-growing areas and will provide a more sanitary product only when he finds his market shrinking while other more forward-looking areas take over. I believe that the date consumer will force more modernization on the industry just as a matter of economics.

SAMPLING OF COMMERCIAL DATE PRODUCTS

Hillman Yowell
California Date Growers Association

At the close of the meeting, members of the Date Growers' Institute were guests of California Date Growers Association, who served coffee and date confections. Ladies of the association had baked date cakes, muffins, breads and tarts using commercial packaged date "Mixes." All companies marketing date mixes were represented and the guests sampled each with considerable enjoyment.

These products have been an important factor in marketing the entire crop of California dates, and according to the manager of the Date Administrative Committee, all indications point to a shortage of California dates to supply market demands for 1961-1962.

Date Growers' Institute - 1961 Membership

(As of September 1, 1961)

SUSTAINING MEMBERSHIPS

Thomas R. Brown	Thermal
Edna Langdon Cast	Mecca
Date Administrative Committee	Indio
Dr. J. R. Furr	Indio
David Rogers	Winterhaven
Sunipalms Date Garden	Indio
Leonhardt Swingle	Indio
Leland J. Yost	Thermal

REGULAR MEMBERSHIPS

Burnham Adams	Playa del Rey
Cecil Adams	Thermal
R. Holland Adams	Indio
Adohr Farms	Los Angeles
Al-Aman Ranch, Inc.	Indio
Lloyd Alexander	Thermal
Allah Date Gardens	Indio
Sarah M. Allen	Indio
A. Antoyan	Los Angeles
James Arkell Estate	Indio
J. M. Armstrong	Coachella
Alfonsa Arriola	Palm Desert
S. A. Azhderian	Thermal
L. S. Barnes Estate	Long Beach
E. Benary	Hajarden (Jordan)
H. M. Benninghoff	Palm Desert
B. E. Bensinger III	Beverly Hills
Dr. H. Biermer	San Mateo
Harry Bissell	Miami, Florida
R. W. Blackburn	Thermal
Lee R. Blevins Estate	Indio
Lewis Blumberg	Sherman Oaks
Frank Bogert	Palm Springs
Louis H. Boyar	Beverly Hills
Dr. A. M. Boyce	Riverside
Alberto Breyer	Buenos Aires, Argentine
Drs. Brower, Ortman & Patterson	Duarte
Robert P. Bruce	San Bernardino
Roderick Burnham	Palm Springs
Steve Burton	La Verne
Busy Bee Ranch	Indio
Edward Cain	San Fernando
California Date Growers' Assoc.	Indio
D. L. Cameron & John P. Powell	Coachella
Elizabeth S. Campbell	Los Angeles
Ted Carlson	Indio
Dr. R. J. Carreon	Indio
H. L. Cavanagh	Indio
Norbert L. Chaplicki	Rancho Mirage
Erthie Clayton	Coachella
C. C. Clancy	Palm Desert
Coachella Ranches	Riverside
E. J. Codekas	Thermal
Mrs. Pauline Codekas	Thermal
Tellis Codekas	Indio
Gordon Cologne	Indio
Robert E. Cook	Indio
W. W. Cook	Palm Desert
O. H. Corvington	Akron, Ohio
Bette L. Crawford	Los Angeles
Marjorie B. Crommelin	Palm Springs
Dr. William V. Cruess	Berkeley
Elmer Crunk	Mecca
John T. Culbertson, Jr.	Bakersfield
Dates Officer	Berbera, Somaliland Prot.
Da Vall Date Garden	Cathedral City
Dr. Raymond H. Davis	Los Angeles
R. S. Dillman	Winterhaven
Dr. Robert J. Dostal	Santa Monica
W. C. Drury	Coachella
D. D. Dunlap	Thermal
Ivan Eastes	Indio
Echols Ranch	Thermal
Dick Edwards	Rancho Mirage
El Dorado Palms Estates, Inc.	Palm Desert
Harold Elmer	Riverside
Tom W. Embleton	Riverside
Ranchito Escondido	Rancho Mirage
Keith Farrar	Indio
George Feldstein	Thermal
Homer Fetty	Thermal
Mrs. J. Blake Field	Palm Springs
Pauline Findeisen	Palm Desert
Ursula de Fontenay	Alice Springs, Australia
Thomas J. Fox	Santa Monica
Chris Frank	Coachella
M. Franklin	Coachella
Sidney Orlando Gandra	Sao Paulo, Brazil
Earle Stanley Gardner	Desert Hot Springs
Mildred L. Garner	Beverly Hills
Mert Gayler	Thermal
Montie Gaylor	Thermal
Elton Gebhardt	Thermal
H. L. Gee	Beverly Hills
George E. Gibbs	Thermal
Mabel E. Gibbs	Thermal
J. P. Gonzales	Indio
G. & P. Ranch	Indio
Horace Hagerty	Thermal
Webb Hansen	Los Angeles
J. D. Harms	La Quinta
Fred Harvey	Death Valley
Dr. K. S. Hayes	Indio
K. D. Hayward	Indio
A. Herbekian	Thermal
William Hickey	Indio
Dr. Robert Hilgeman	Tempe, Arizona
Leo Hirsh	Sherman Oaks
Frank Hirst	Coachella
Robert M. Howie, Co. Agri. Com.	Riverside
Larry Hughes	Los Angeles
City of Indio	Indio
Institut Francois de Recherches	Republique Islamique de Mauritanie
Institut Francois de Recherches	Paris, France
James & Carrie L. Jackson	Indio

Homer B. Jamison .... Indio
E. C. Jarvis .... Thermal
Norval Jarvis .... Thermal
Rancho del J., Inc. .... Santa Ana
Delbert Johnson .... Thermal
May E. Johnson .... Winterhaven
Ronald Johnson .... Thermal

Ed Kandarian .... Coachella
Kanter Date Gardens .... Cathedral City
Albert P. Keck .... Indio
Phyllis Kelley .... Indio
Mrs. William Kersteiner .... Coachella
Elmer Kinder .... Indio
Jack Kitagawa .... Thermal
Konjoyan Bros. .... Thermal
Louis Krall .... Calexico
Ed Kroeger .... Indio

Ben Laflin, Jr. .... Thermal
Ben Laflin, Sr. .... Thermal
Uri Landan .... Doar Na Beit Shan, Israel
La Quinta Hotel .... Indio
K. K. Larson .... Palm Springs
George Leach .... Thermal
Leslie Ranches Nursery .... Indio
Kenneth Lichty .... Indio
Eugene Lincoln, Jr. .... Thermal
Dr. David Lindgren .... Riverside
Gardner Lippencott .... Palm Desert
Paul V. Lockwood .... Indio
Dr. E. G. Longley Ranch .... Thermal
Karl Lundberg .... Indio
L. & M. Ranch .... Coachella

J. F. Mackenzie Estate .... Indio
Mrs. Clarice Magaw .... Palm Desert
Martha Reid Martin .... Rancho Mirage
Kelly McBean .... Indio
Mrs. Ralph McCurdy .... Pasadena
R. C. McCurdy .... New York City
John McGonigle .... Pacific Palisades
Gregory McKeever .... Corcoran
Norman McLeod .... Palm Springs
Paul E. McMaster .... Beverly Hills
Miller & Dunlap .... Glendale
D. H. Mitchell .... Indio
Mitchell & Robison .... Indio
D. C. Mock, M.D. .... Redlands
W. W .Moore .... Cathedral City
R. E. Moran .... Hermosa Beach
Nick T. Moschetti .... Rancho Mirage
Arthur B. Muhs .... Davenport, Iowa
Dudley Murphy .... Malibu

Dr. O. M. Naranjo .... Los Angeles
Fred C. Nash .... Pasadena
Mrs. Helen Nelson .... Los Angeles
Lyle Newcomer Estate .... San Marino
Dr. Leon L. Newman .... South Gate
Willis Newsom .... Anaheim
Roy W. Nixon .... Indio

J. J. O'Brien .... Indio
William O'Connell .... Palm Desert
Bruce W. Odlum .... Indio
Floyd B. Odlum .... Indio
Joseph O'Rourke .... Thermal
S. D. Overholtzer .... Thermal

Ila M. Page .... Cathedral City
K. K. Patterson .... Indio
Albert Peck .... Palm Springs
Pegru Ranch, Norman Waters .... Rancho Mirage
B. J. Peightal .... Indio
Peter Rabbit Farms .... Coachella
Phillips & Flowers .... Indio
R. A. Pinyan .... Indio
Homer Pierce .... Cathedral City
Rollins Pierson .... Los Angeles
Harry Clay Pollock .... Tucson, Arizona
Portola Ranch .... Indio
Anna K. Pryor .... Los Angeles
J. Harold Puls .... Indio
Walter Pulsifer .... Thermal

Joseph Rapkin .... Milwaukee, Wisconsin
Rancho Ramona .... Indio
K. W. Ranney .... Santa Ana
Joseph Rapkin .... Milwaukee, Wisconsin
Dr. Walter Reuther .... Riverside
H. B. Richardson .... Davis
H. C. Richert .... Indio
Donald Robinson .... Indio
John Rodriguez .... Indio
Elizabeth H. Rohrs .... Orange
James E. Ross .... Indio
R. R. J. Ranch .... Indio
Maxwell Ruben .... Beverly Hills
Will D. Rudd .... San Diego
Rummonds Bros. .... Thermal
Robbins Russel .... Thermal
Dr. G. L. Rygg .... Pomona

Tom Sakai .... Indio
Henry M. Schmid .... Coachella
Thomas Schmid .... Coachella
Walter Schmid .... Garden Grove
Martin Schwarzburd .... Los Angeles
Shields Date Gardens .... Indio
Fred Siemen .... Palm Desert
Jackson W. Smart .... Rancho Mirage
Smart-Hartman .... Rancho Mirage
Dr. Rodney H. Snow .... Santa Monica
Joseph Strehle .... Longview, Washington
Mrs. Walter T. Swingle .... San Francisco

Lawrence G. Thielemeir .... Santa Ana
Howard Turk .... Coachella

W. E. Urick Ranch .... Los Angeles

Valerie Jean Date Shop .... Thermal
Valli-Hi Ranch .... Riverside

A. H. Van de Kamp .... Bellevue, Washington
Bernard H. van der Steen .... Indio
Venus Foods .... Los Angeles

Dr. Joseph Walker .... Hollywood
Norman Waters Ranch .... Rancho Mirage
Webb Farms .... Thermal
Robert W. Webb, Jr. .... Palm Desert
Dr. Aaron Weiner .... Indio
Col. Neil W. Wemple .... A.P.O., N.Y.
James P. Westerfield .... Mecca
John Westerfield .... Coachella
Western Province Fruit Research Station .... Stellenbosch, South Africa
Harold E. Williams .... La Jolla
Gwynn Wilson .... Indio
Victor Wilson .... Beverly Hills
Olin Wilson .... Coachella
George Woodbury .... Indio
Allene Woolard .... Santa Monica
Dr. R. E. Zimmerman .... Thermal